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ABSTRACT

This curriculum guide provides topic outlines and objectives for units in a three-level/-course Power Technology program. Introductory materials are objectives for industrial education and for power technology and list of general safety rules. Units contained in Level I, Power Technology, are History of Power, Basic Machines, Forms of Power, Power Resources, Basics of Electricity, Measuring Energy, The Energy of Motion, Hydraulics, Pneumatics, Types of Engines, and Small Gasoline Engines. Level II, Introduction to the Automobile, has these units: Introduction to the Course, Engine Operation, Cooling System, Brakes, Electrical System, Lubrication, Fuel System, Ignition System, Introduction to Shop Activities, Manual Transmission, and Clutches. Units in Level III, Advanced Automotive Mechanics, are Introduction to the Course, Cooling System, Ignition, Emissions, Fuels, Engines, Suspension, Steering, Alignment, Charging Systems, Starting Systems, Differentials, and Air Conditioning. (YLB)

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INDUSTRIAL ARTS CURRICULUM GUIDE

FOR

POWER TECHNOLOGY

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
NATIONAL INSTITUTE OF EDUCATION

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State Department of Education
Division of Vocational and Adult Education
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TABLE OF CONTENTS

	Page
Introduction	3
Objectives	5
General Safety Rules	6
Level I, Power Technology	8
Level II, Introduction to the Automobile	26
Level III, Advanced Automotive Mechanics	40
Suggested Bibliography	54

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INTRODUCTION

This curriculum guide is written in general terms. It is realized that program lengths and objectives vary from one community to another. The purpose of this guide is not to restructure all existing programs, but rather to serve as an example of a complete Power Technology program. This guide will be particularly useful to a beginning teacher, but will also help an experienced teacher to update and upgrade his/her course of study.

This curriculum guide is broken down into three levels:

1. Power Technology
2. Introduction to the Automobile
3. Advanced Automotive Mechanics

In general, it is the school system that determines the type of program to be taught. Very rarely does the teacher have the choice of designing the program. The teacher must, however, fit a workable curriculum into the guidelines set forth by the school system. Some school systems have as little as two semesters of "Power Mechanics" in which the introductory level deals with small engines and the second level deals with the automobile. Other systems have three full years in which an entire, fully developed program may be presented.

This guide is written with these variables in mind. It is meant to be a flexible tool, not a rigid structured device in which everything must be

covered. If, for example, the school system has a full three year program, this guide will be useful in its entirety. If, however, the length of the program is two years, or only two semesters, then the first two levels may be presented if the school does not have good shop facilities. If the facilities are good, the last two levels may be presented. In addition, the degree to which the guide is followed in each particular level, is at the discretion of the teacher.

It should be realized, that this guide has been prepared with the intention of being as up to date as possible. With the rapid changes in technology however, it will soon be out of date. It is up to the teacher therefore, to keep both himself and his course of study up to date in terms of the latest developments in the field.

OBJECTIVES - INDUSTRIAL EDUCATION

1. To provide students with the curriculum content designed to develop fundamental tool and procedural skills which help prepare them to enter a family of occupations.

2. To provide students with courses that serve as vehicles which help them relate their academic knowledge to vocational competencies.

3. To provide students with the environment whereby they may develop sound attitudes, acceptable work habits, and achieve a feeling of accomplishment.

OBJECTIVES - SPECIFIC TO POWER TECHNOLOGY

The Power Technology courses should give students an opportunity to:

1. Obtain exposure to, and a basic understanding of, the career field.

2. To develop methods of analytical thinking related to power technology problems.

3. To develop technical knowledge, attitudes and skills required in the power technology service area.

4. To develop an awareness of the impact of power technology on society.

GENERAL SAFETY RULES

In schools, as well as at home and in industry, it is realized that all of our efforts are directed toward the betterment of man's life. Therefore, protection from the inherent dangers in the environment is essential.

The following is a list of general shop safety rules that are applicable to all shop areas. Specific additions and alterations may be necessary depending on the shop and the equipment available.

The student will demonstrate his/her knowledge and mastery of the following rules to the instructor before permission to work in any shop will be granted.

1. Proper attire must be worn
2. Eye protection must be worn when necessary
3. Horse-play is not permitted
4. Injuries (no matter how slight) must be reported to the instructor immediately
5. Do not use any equipment until properly instructed and permission is granted
6. The student will have a working knowledge of the following:

   How to get help

   School office

   School nurse

   Fire department

Use of fire extinguishers

Use of emergency shut-off switches

Ventilation of the shop

Handling of exhaust gas

Storage of oily rags

Storage of combustible liquid

Handling sharp tools

Lifting heavy objects

Safety glasses

Tool storage

LEVEL I, POWER TECHNOLOGY

I. HISTORY OF POWER - Upon completion of this unit, the student will understand:

Early Man

Muscle Power

human

animal

Sun

Wind

Water

Fire

Modern Man (1000 BC to Present)

Use of Animal Power

Use of Wind Power

early windmills

early sailing ships

Use of Water Power

development of water wheel

Chinese Water Chain

undershot water wheel

overshot water wheel

Breast water wheel

Early Engines

External Combustion Engine

Hero's Engine - Greece 50 B.C.

First successful steam engine James Watt - 1765

Internal Combustion Engine

Christian Hygenes - later 17th century

Otto & Langen - 1878... 1st practical internal combustion engine

diesel engine

gas turbine engine

jet engine

rocket engine

II. BASIC MACHINES - Upon completion of this unit, the student will understand:

Lever

1st Class Lever (e.g., seesaw)

2nd Class Lever (e.g., pry bar)

3rd Class Lever (e.g., hammer)

Wheel and Axle

Pulley

Inclined Plane

Screw

Wedge

III. FORMS OF POWER - Upon completion of this unit, the student will understand:

Work - force applied to cause motion

Measurement of Work

$$\frac{\text{WORK}}{\text{(ft. lbs.)}} = \frac{\text{FORCE}}{\text{(Pounds)}} \times \frac{\text{DISTANCE}}{\text{(feet)}}$$

Law of Conservation of Energy - energy can change form but it cannot be destroyed.

Efficiency of Machines

$$\text{EFFICIENCY} = \frac{\text{OUTPUT}}{\text{INPUT}} \times 100 \quad \text{or}$$

$$\text{EFFICIENCY} = \frac{\text{INPUT - LOSSES}}{\text{INPUT}} \times 100 \quad \text{or}$$

$$\text{EFFICIENCY} = \frac{\text{OUTPUT}}{\text{OUTPUT}} + \text{LOSSES} \times 100$$

Power - is the rate of doing work and the rate of energy conversion.

Measurement of Power

$$\text{POWER} = \frac{\text{WORK}}{\text{TIME}} \qquad \frac{\text{(ft. lbs.)}}{\text{(sec.)}}$$

Horse Power

$$\text{HORSEPOWER} = \frac{\text{W O R K}}{\text{Time (in sec.)} \times 550}$$

$$\text{HORSEPOWER} = \frac{\text{W O R K}}{\text{Time (in min.)} \times 33{,}000}$$

Potential Energy - "energy, a body has due to its position, its condition, or its chemical state."

Position - water at the top of a waterfall

Condition - a tightly wound spring

Chemical - fuels

Kinetic Energy - energy of motion, released potential energy.

IV. POWER RESOURCES - Upon completion of this unit, the student will understand:

Nuclear Power

Nature of Matter

atom

electron

neutron

proton

elements

compounds

Atomic Fussion

Atomic Fission

Nuclear Reactor

Solar Power - Sun gives light and heat

Early experiments with reflectors and mirrors

Thermopile - 1863

Photogalvanic Cell - 1839

Barrier - laser photovoltaic cell - 1876

Improved photovoltaic cell - 1954 (solar battery)

Fuel Cell

Components

Operation

Thermo Electricity

Geothermal Power

Bio-Fuels

V. BASICS OF ELECTRICITY - Upon completion of this unit, the student will understand:

Electricity

atomic theory

structure of atom

electron
neutron
proton
nucleus

Conductors and insulators

Electrical Terms

Voltage -

Unit of measurement - volts

Current -

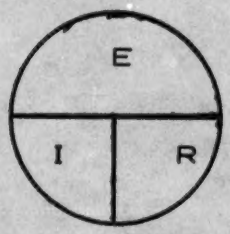
Unit of measurement - Amperes (AMPS)

Resistance -

Unit of measurement - OHMS

OHMS LAW - Relationship between VOLTAGE, CURRENT, AND RESISTANCE.

Use of Magic Circle - Used to find a missing value. In this equation when two values are known.



Formulas

To find Voltage	$E = I \times R$
To find Current	$I = E/R$
To find Resistance	$R = E/I$

Series Circuits

Definitions and terms related to Series Circuits

Operation of a Series Circuit in Terms of Voltage, Current, and Resistance

Parallel Circuits

Definitions and Terms related to Parallel Circuits

Operation of a Parallel Circuit in Terms of Voltage, Current, and Resistance

Meters

Instruments for Measuring Voltage, Current, and Resistance Values.

Application of Meters

Set-up of meters

Safety requirements in their use

VI. MEASURING ENERGY - Upon completion of this unit, the student will understand these units of measurement.

Work

Motion caused by applying force

Work is measured in foot/lbs.

Work is found by multiplying the force times the distance

Force

Any push that can be measured on a scale is force

Force may be measured the same as weight in ounces, pounds, and tons

Usually measured in Ft/Lbs. or Lbs. per Ft.

Torque

Torque is a measurement of twisting or turning force

Usually measured in Ft/Lbs or In/Lbs.

Found by multiplying force x radius

Power

How long it takes to do the work

The rate of work being done

Measured in Ft/Lbs per second or minute

Horse Power

The amount of work that could be done by the average horse

1 Hp = Move 550 ft/lbs in one second

1 Hp = Move 33,000 ft/lbs in one minute

Watts

Usually a measurement of electrical energy

May be found by using the power formula W = Volts x Amps

746 Watts = 1 Horse Power

British Thermal Unit

A measurement of heat energy

276 BTU/hour = 1 horse power

One BTU = 252 Calories

VII. THE ENERGY OF MOTION - Upon completion of this unit, the student will be able to apply these terms:

INERTIA

A body at rest tends to remain at rest unless acted upon by another force. A body in motion tends to remain in motion going in a straight line unless acted upon by another force.

FRICTION

Is the resistance to motion that occurs between two objects when they touch each other. When motion is altered by friction, energy is given off as heat.

MECHANICAL ADVANTAGE

Is a change in ratio between force and distance while the work input and the work output remain the same.

MECHANICAL TRANSFER OF ENERGY

Pulleys and Belts

V-Belts

V-Belt Pulleys

Multiple V-Belt Assemblies

Toothed Pulleys

Timing Belt Assemblies

Chains and Sprockets

Roller Chains and Sprockets

High Speed Chains and Sprockets

Specialty Chains

Gears

- Spur Gears
- Helical Gears
- Bevel and Miter Gears
- Worm Gears

Clutches

- Friction Clutches
- Positive Drive Clutches
- Overrunning or Freewheeling Clutches
- Couplings

VIII. HYDRAULICS - Upon completion of this unit, the student will understand the basic principles of hydraulics:

A liquid cannot be compressed

Pascal's Law: "The pressure at any point in a static liquid is the same in every direction and exerts equal force on equal areas".

The ratios for input and output of a static fluid power system may be equated to a lever.

(WORK = FORCE x DISTANCE)

HYDRAULIC COMPONENTS

Reservoir

Tubing pipes and hoses

Pumps

Valves

Motors

Cylinders

Hydraulic Fluids

IX. PNEUMATICS - Upon completion of this unit, the student will understand the basic principles of pneumatics:

Pascals Law: "The pressure at any point in a static fluid is the same in every direction and exerts equal force on equal areas".

Gases may be compressed

Temperatures cause a wide variation in pressure

Boyle's Law: "The absolute pressure of a combined body of gas is inversely proportional to the volume, provided the temperature remains constant".

Air is the most common pneumatic fluid

PNEUMATIC COMPONENTS

Pump or compressor

Reservoir or storage tank

Hoses or pipes

Valves

Motor or Pneumatic cylinder

X". TYPES OF ENGINES

RECIPROCATING STEAM ENGINE

Uses an external boiler

Piston and cylinder

Slide valve

Crankshaft and flywheel

STEAM TURBINES

In wide use today

Use rotors instead of pistons

Uses an external boiler

INTERNAL COMBUSTION ENGINES

Two stroke reciprocating gasoline engines

Four stroke reciprocating gasoline engines

Diesel engines

Gas turbine engines

Rotary Engines

Jet engines

Rocket engines

XI. SMALL GASOLINE ENGINES

At this time in the development of technology, the internal combustion engine is the most widely used of all engines. Millions of automobiles and millions more small gasoline engines are manufactured each year. The small gasoline engine being readily available and representative in design was chosen here to represent the principles and theory of operation of the internal combustion engine.

SAFETY RULES FOR SMALL GASOLINE ENGINES

Never put gasoline in the throat of a carburetor

Always use the right tool for the job

Do not attempt to start an engine unless it is mounted properly

Start an engine only with the instructors permission

Always store gasoline in the proper container and keep the container in the proper storage area

Have a fire extinguisher near by

Only start an engine in an area with the proper ventilation

* Always <u>REMOVE</u> the spark plug before working under a lawn mower. Many hands and feet have less than five fingers or toes because of not following this rule.

SMALL GASOLINE ENGINES

Theory of the four stroke cycle reciprocating gasoline powered engine.

Power at every other rotation.

THE BASIC ENGINE

Cylinder block and head

Piston, pin and rod

Crankshaft and bearings

Camshaft and timing gears

Valves and lifters

FUEL SYSTEMS

Carburetors

Storage, filters and fuel lines

Fuel pumps

LUBRICATION

Classifications of oil

Oil pumps and splashers

IGNITION SYSTEM

Magneto theory and operation

Battery ignition

STARTING SYSTEMS

COOLING SYSTEMS

THEORY OF 2 STROKE CYCLE ENGINE

Power at every rotation

Reed valves

Rotary valves

Loop Scavenging

Cross Scavenging

Oil/Gasoline Mixtures

LEVEL II, INTRODUCTION TO THE AUTOMOBILE

I. INTRODUCTION TO THE COURSE

Upon completion of this unit, the student will understand.

Reasons for taking this course

Course content

Course philosophy

Student goals and objectives

Student responsibilities

The value of reading and self study

The emphasis placed on safety

Effect of the automobile industry on the economy

Career opportunities in the automotive field

A brief history of the automobile

The basic construction of the automobile with respect to:

- Engine
- Frame
- Power train
- Body

II. ENGINE OPERATION

Upon completion of this unit, the student will understand:

Types of engines

External combustion

Internal combustion

Spark ignition

Four stroke cycle

Two stroke cycle

Rotary

Compression ignition (Diesel)

Four stroke cycle engine operation

Definition of cylinder and engine designation by number of cylinders
Construction of the engine block, and the materials used
Piston and nomenclature of component parts
Combustion of fuel in terms of the change of chemical energy into energy of motion
The crank as a means of converting reciprocating motion into rotary motion
Crankshaft and the function of main bearings
The need for systematic movement of air and fuel into cylinder and end products out of cylinder
Cylinder head, spark plug opening, valves, valve train and camshaft
Sequince of strokes
Methods of driving the camshaft and the relationship between camshaft and crankshaft speed
Intake manifold and carburetor, and method of fuel delivery to the intake valve
Exhaust manifold and method of exhaust flow out away from the exhaust valve
Water jacket
Flywheel and its purposes

Two stroke cycle engine operation (as covered in Level I)

Compression Ignition (Diesel) Operation

Diesel engine cycles

Four stroke cycle
Two stroke cycle

Similarities of diesel and gasoline engines

Cylinder block, pistons, connecting rods, crankshaft lubrication system, cooling system, camshafts, valve arrangements, starting motors

Differences between diesel and gasoline engines

Diesels have heavier construction, compression ignition, higher compression ratios, injection type fuel systems, and are more efficent

Differences among diesels

Fuel systems, combustion chamber design, method of supplying air, speed of operation

Rotary engine operation

Component identification

Rotary engine theory of operation

Two rotor vs. one rotor engines

Comparison of rotary engine to poston engine

Engine measurements

Definition of terms (as covered in Level I)

Work
Energy
Power
Torque
Horsepower
Inertia
Friction

Definitions of:

Bore and Stroke
Piston displacement
Compression ratio
Volumetric efficiency
Brake horsepower
Indicated horsepower
Friction horsepower
Engine torque
Engine efficiency

III. COOLING SYSTEM

Upon completion of this unit, the student will understand:

Need for cooling the engine

Two basic types of cooling systems (Air and Liquid cooling)

Air cooling

The purpose of cooling fins as an increase in surface area

Liquid cooling

Components identification and their purposes
Engine water jacket
Water pump
- Nomenclature and purposes of component parts (housing, impeller, seal and bearing)
- Operation of impeller and water flow through pump
- Failure modes and identification of same
  - Bearing squeal
  - Seal leak

Fan
- Purpose of fan and method of drive
- Clutch type fan
- Electric fans
- Safety hazard of moving fan
- Safety hazard of fan blade breakage
- Safety hazard of V-belt
- Procedure for belt inspection
- Procedure for belt adjustment

Radiator
- Purpose of radiator
- Two basic types of radiators
  - Down flow
  - Cross flow
- Inlet and outlet fittings, cap opening, drain petcock and transmission cooler fittings

Heater
- Purpose and operation as a small radiator
- Methods of heat control
  - Air flow control
  - Water flow control

Hoses
- Need for flexibility of hoses

- Types of hoses (molded and universal)
- Direction of coolant flow through all components and hoses
- Hose inspection

Thermostat
- Location and purpose
- Bypass methods
- Effect of failure modes:
  - Stuck open
  - Stuck closed

Pressure caps
- Blow-off valve and vacuum valve
- Purposes of cap:
  - Prevents surge losses when cornering
  - Permits pressure build-up to raise boiling point
  - Prevents vacuum condition in system during cool-down
- Safety hazard of removing hot radiator cap
- Cooling recovery systems
- Procedure for testing pressure caps

Antifreeze
- Purposes of antifreeze
  - Lowers freezing point
  - Raises boiling point
  - Contains rust inhibitor
- Replacement interval
  - Cast iron blocks
  - Aluminum blocks
- Determination of amount required
- Draining and flushing system
- Refilling system
  - Conventional system
  - Coolant recovery system
- Antifreeze testing
  - Hydrometer theory of operation
  - Procedure for testing antifreeze with a hydrometer

Workshop activities
- Pressure testing system
- Removal and replacement of hoses
- Flushing system
- Removal and replacement of fan belts
- Adjusting fan belts
- Antifreeze testing

IV. BRAKES

Upon completion of this unit, the student will understand:

The need for and the importance of properly operating brakes
That brakes convert kinetic energy into heat by means of friction
Drum brake operation
Types of brakes
    Mechanical brakes
    Hydraulic brakes
The basics of hydraulics (from Level I)
Master cylinder and wheel cylinder operation
Procedure for master cylinder fluid level check
Types and qualities of brake fluid
The need for bleeding brake hydraulic system in terms of compressibility of air, and relation to pedal "feel"
Procedure for brake bleeding
Nomenclature of drum brake components
Bendix brake operation and self energizing feature
Operation of self adjustors
Types of linings
    Riveted
    Bonded
    Composition vs. metallic
Wear limits of linings (riveted and bonded)
Procedure for performing a brake job
Emergency brake adjustment
Disc brake operation and advantages over drum brakes
Disc brake wear limits and disc sensors
Procedure for performing a disc brake job
Hydraulic assist rear disc brakes
Safety hazard of high pressure in accumulator
Purpose of front wheel bearings
Procedure for repacking front wheel bearings
Procedure for adjusting wheel bearings
Workshop activities
    Brake inspection
    Repacking front wheel bearings
    Adjusting front wheel bearings

V. ELECTRICAL SYSTEM

Upon completion of this unit, the student will understand:

The fundamentals of electricity as covered in Level I
Operation of voltmeters, ammeters and ohmmeters
Automotive wiring in terms of one-wire and two-wire systems
Circuit faults
    Open circuits
    Short circuits
Fuses and fusible links (theory of operation and methods of replacement)
General lamp replacement
Test lamps and circuit checks
Checks of various accessories using a test lamp
Voltmeter circuit checks
Battery theory of operation and cell construction
Charge and discharge in terms of chemical composition of battery
Electrolyte composition as an indicator of state of charge
Hydrometer theory of operation
Hydrometer check of battery state of charge
Safety hazard of working with battery without safety glasses
Danger of hydrogen gas in terms of sparks, cigarettes, etc.
First aid for acid spills on skin, eyes, clothes, etc.
Electrolyte level check and refill
Procedure for battery terminal cleaning
Proper use of jumper cables
Proper method of removing and replacing a battery
Proper method of charging a battery
Maintenance free batteries and comparison to conventional batteries
Charging of maintenance free batteries and possible safety hazards
Operation of the charging system
Generators and alternators: theory of operation
Voltage regulator operation
Charging system voltage test
Starter motor operation and starter drives
Operation of relays and solenoids
Neutral safety switches
Basic ignition operation (Conventional and Solid State)
Workshop activities
    Fuse and lamp replacement
    Circuit checks with a test light
    Circuit checks with a voltmeter
    Hydrometer tests
    Battery electrolyte level check
    Battery terminal cleaning
    Use of jumper cables
    Use of battery charger

VI. LUBRICATION

Upon completion of this unit, the student will understand:

- Purpose of lubrication
- Need to adopt a periodic maintenance routine
- Engine lubrication
  - Oil pan, oil pump, oil filter, oil pressure sending unit, and oil galleries
  - Oil flow to valve train, main and connecting rod bearings
  - Viscosity and SAE ratings
  - Body and fluidity of oil
  - The formation of sludge
  - Procedure for checking oil
  - Procedure for changing oil and filter
  - Oil change interval recommendations
  - Proper disposal of drained oil (Environmental considerations)
  - Origin of crankcase vapors and operation of crankcase ventillation systems
  - Road draft tube and effect on air pollution
  - PCV system
  - Procedure for servicing PCV valve, PCV inlet air filter and/or breather cap
- Transmission lubrication
  - Purpose of transmission in terms of power flow and gear ratios
  - Manual transmission fluid check and types of gear oil
  - Automatic transmission fluid check and types of ATF
  - Purposes of ATF in terms of lubricating, cooling and transmitting forces
  - Need to change fluid at regular intervals
- Power steering systems
  - Operation of power steering system
  - Power steering fluid level check
- Differential
  - Purpose of differential in terms of power flow and gear ratio
  - Differential gear operation
  - Differential gear oil check and types of gear oil
  - Limited slip differential and relation to conventional differential
  - Gear oil used with limited slip differential
- Chassis lubrication
  - Identification of steering linkage components
  - Procedure for lubrication of steering linkage components and types of chassis grease
  - Procedure for lubrication of door latches, hinges, etc.
- Workshop activities
  - Engine oil check
  - Oil and filter change
  - Manual transmission gear oil level check

Automatic transmission fluid level check
Power steering fluid level check
Differential gear oil level check
Grease job

VII. FUEL SYSTEM

Upon completion of this unit, the student will understand:

Purpose of fuel system, and identification of components
- Fuel tank
- Fuel tank caps (vented and non-vented)
- Fuel tank sending unit
- Steel fuel line
- Flexible fuel line
- Fuel pump
- Fuel filters
- Carburetor

Gasoline
- Gasoline as a hydrocarbon compound
- The manufacturing process of refining crude oil
- Products of perfect combustion
- The pollutants emitted as a result of imperfect combustion
- Safety hazard of CO
- Volatility
- Detonation and preignition
- Octane ratings
- Use of tetraethyl lead and other additives
- Effect of compression ratio on detonation and octane requirement
- Lower compression ratios and lower octane unleaded fuels

Diesel fuel
- Diesel engine compression ratios
- Heat of compression
- Cetane rating

Fuel pump
- Identification of components (Diaphragm, inlet and outlet valves, etc.)
- Operation of pump during full flow and partial flow modes
- Failure modes and symptoms
- Operation of single and dual action fuel pumps

Fuel filters
- Location of fuel filters and service intervals
- Types of fuel filters and proper service procedures for each

Carburetor
- Air/fuel ratio requirements of engine with respect to engine operating modes and road speed

- Carburetor air intake system
  - Air filter and recommended service intervals
  - Heated air inlet system
- Intake manifold vacuum and relation to carburetor operation
- Basic carburetor operation (Venturi effect, fuel nozzle, atomization vs. vaporization, air bleeds, etc.)
- Throttle valve and effect on engine speed
- Fuel inlet system
- Carburetor jets, as a method of metering fuel
- Idle system
- Low speed system
- High speed part throttle system
- High speed full throttle system (fuel enrichment)
- Accelerator pump system
- Choke operation

Carburetor adjustments

- Use of a tachometer
- Procedure for adjusting idle speed
- Procedure for adjusting idle stop solenoid (anti-dieseling solenoid)

Fuel injection

- Theory of fuel injection
- Types of fuel injection
- Component identification
- Electronic fuel injection

Workshop activities

- Air filter replacement
- Operational check of heated air inlet system
- Fuel filter replacement
- Disassembly and reassembly of a carburetor
- Idle speed adjustment

VIII. IGNITION SYSTEM

Upon completion of this unit, the student will understand:

Purpose of the ignition system
"Tune up" as a repair function of the ignition system
Identification and purpose of the following ignition components:
- Ballast resistor
- Ignition coil
- Distributor
- Ignition wires
- Spark plugs
- Points and condenser
- Rotor

Firing order
Ignition system schematic diagram
Detailed operation of the ignition system
Points, rotor and spark plug wear, and the effect on the ignition system operation
Points and condenser replacement on a Ford distributor
Point adjustment with a feeler gauge
Points and condenser replacement on a General Motors distributor
Dwell
Procedure for adjusting dwell with a dwellmeter
Spark timing and relation to engine power
Procedure for measuring ignition timing with a timing light
Centrifugal advance and relation to engine speed
Vacuum advance and relation to engine load
Spark plugs (thread diameter, washer vs. tapered seat, reach, heat range, etc.)
Procedure for spark plug removal and replacement using proper torque specifications
Proper sequence of tune-up operations
Solid state ignition systems and comparison to breaker point ignition systems
Component identification of the various solid state systems
Magnetic triggering of spark
Hall Effect triggering of spark
Tune up operations and adjustments on solid state systems
Workshop activities
- Replacement of points, condenser and rotor
- Adjustment of points with a feeler gauge
- Adjustment of points with a dwellmeter
- Timing measurement and adjustment
- Spark plug replacement
- Air gap adjustment on Chrysler magnetic distributor

IX. INTRODUCTION TO SHOP ACTIVITIES

Upon completion of this unit, the student will understand:

Tire service
- Procedure for changing a wheel and tire (safely), with respect to placement of vehicle jack, proper body mechanics, etc.
- Procedure for proper use of floor jack
- Differences between bias ply and radial tires
- Tire rotation patterns (bias and radial ply)
- Tire pressure
- Tire sizes, grades, etc.
- Tire inspection (wear bars, tread defects, ply separation, etc.)
- Tire repair techniques
- Tire balancing (static, dynamic)

Windshield wiper service
- Removal and replacement of various wiper insert types

Exhaust systems
- Exhaust system inspection
- Procedure for removal and replacement of exhaust system components

Workshop activities
- Tire changing and rotation
- Checking tire pressure
- Removal and replacement of windshield wiper inserts
- Replacement of exhaust system components

X. MANUAL TRANSMISSION

At the end of this unit, the student will understand:

- The purpose and operation of manual transmissions
  - Torque multiplication
  - Power flow
  - Sliding gears
  - Constant mesh gears
  - Sychronizer action
  - Shift mechanisms
  - Lubrication
- Transmission components
  - Mainshaft assembly
  - Countershaft assembly
  - Reverse idler assembly
  - Input shaft
  - Gears
  - Synchronizers
  - Shifter fork assemblies
  - Bearings
  - Seals and gaskets
  - Case
- Troubleshooting and diagnosis
  - Transmission shifts hard
  - Gears clash when shifting
  - Transmission is noisy
  - Transmission jumps out of gear
  - Transmission is locked in one gear and cannot be shifted out of that gear
- Transmission servicing
  - Transmission removal
    - Remove shift rods and speedometer cable
    - Drain lubricant
    - Remove drive shaft
    - Support engine
    - Remove transmission cross member
    - Unbolt and remove transmission
  - Disassembly
    - Follow steps listed in service manual
  - Clean and inspect
  - Reassemble
  - Install in vehicle

XI. CLUTCHES

At the end of this unit, the student will understand:

The purpose and operation of clutches
Clutch components
- Flywheel
- Pilot bearing
- Driven plate assembly
- Pressure plate and cover assembly
- Throwout bearing
- Clutch fork
- Clutch housing

Clutch linkage
- Mechanical - levers
- Mechanical - cable
- Hydraulic

Troubleshooting and diagnosis
- Clutch chatter
- Clutch slippage
- Clutch drag
- Clutch pedal pulsation
- Clutch - related vibration
- Clutch area noises

Clutch servicing
- Adjustments
  - Pedal height
  - Clutch pedal free play
- R & R
  - Remove transmission and drive shaft
  - Remove clutch assembly and disc
  - Remove clutch release bearing and sleeve assembly
  - Clean and inspect components
  - Assemble

LEVEL III, ADVANCED AUTOMOTIVE MECHANICS

INTRO TO THE COURSE

Discuss the following:

Reason for taking course
Course content

(Student) Goals and objectives
Student responsibilities
Nature of reading and self-study
Career opportunities
Influence of technology on the vehicle
Influence of fuel conservation and Federal Clean Air Act Ammended 1970

COOLING SYSTEM

Upon completion of this unit, the student will understand:

The purpose and components of cooling system
The by-pass system
The proper pressure testing procedures
- Radiator testing technique
- Radiator cap testing technique
- Safety hazard of pressure testing on a hot engine

Purpose of engine freeze-out plugs
R & R of engine expansion, freeze plug (types, dish, cup, rubber moly)
Engine gaskets failure and detection of damaged or failed gaskets
- Exhaust bubbles in radiator
- Coolant in engine oil
- Fouled spark plugs, etc.

Radiator repair techniques
- Sealers
- Soldering
- Recoring
- Rodding out
- Flow testing

Heater core trouble shooting
- Heater core leakage and diagnosis is W/OA/C, W/AC
- W/AC probability of having to discharge A/C system

R & R waterpump procedures
- Importance of checking two-piece pump bolts
- Importance of thoroughly cleaning mating surfaces and torque on aluminum components

IGNITION

Engine Tune-up

Upon completion of this unit, the student will understand:

- The purpose of an engine tune-up
  - Restore fuel mileage
  - Power
  - Maintain clean air
- The difference between major and minor tune-ups
- Dwell angle and breaker point theory
  - Procedure for installing and setting air gap of breaker pts.
  - Installation and use of dwell meter to set or check points
- Where to find and how to interrupt tune-up specifications
  - Professional manuals
  - Manufacturer's decals, etc.
- The proper sequence of a tune-up
  - The battery
  - Compression test, etc.
  - Point setting
  - Engine R.P.M.
  - Advanced mechanism to correct ignition timing
- Advance curve theory
  - Mechanical adjustments
    - Diagnostic procedures
    - Theory of operation
    - Diagnostic procedures
  - Vacuum advance units (single and dual advance units)
    - Theory of operation
    - Adjustment
    - Diagnostic procedures
- The importance of a complete visual inspect
  - Fluid levels
  - Belts and hoses
  - Reading spark plugs
- How to mark or index dist. for removal and replacement
  - Causes of dwell variation
- Static and monolithic timing and dwell advance settings
- Setting curb idle, throttle solenoid and fast idle speed
- Technique for checking R & R PCV valve
- Checking and cleaning various emission control devices
- Proper road test procedures and clean-up before returning vehicle to owner, if authorized by local educational assoc.

EMISSIONS

Upon completion of this unit, the student will understand:

- Federal Clean Air Act Amendment of 1970, Environmental Protection Agency, and auto-related legislation.
- The three basic emissions
  - Hydrocarbons
  - Carbon monoxide
  - Oxides of nitrogen
- Reference sources for related emission specifications
- Crankcase emission devices
  - Road tubes
  - PCV systems
    - Closed
    - Open
  - Discuss PCV testing, cleaning procedures
- Exhaust system control devices (catalytic converter theory of operation)
  - Pellet type
  - Honeycomb servicing
- Major engine modifications used to reduce emissions, i.e.,
  - Compressions ratios
  - Combustion chamber shape
  - Valve port shape
  - Camshaft designs
  - Raising engine termperatures
  - Leaner mixtures
  - On-board computers
- Engine Control devices theory
  - Exhaust gas recirculation valves
  - Transducer valves
  - Thermactor (air pump systems)
  - Anti-backfire valves/one-way check valves
  - Dump valves/Decel valves
  - Temperature control switches
  - Spark Delay valves/Ported vacuum switches
  - Electric chokes/heat risers
- Evaporative emission control theory & components
  - Charcoal canister
  - Fuel caps
    a. Vented
    b. Non-vented
- The use of exhaust gas analyzer
  - Demonstrate calibration
  - Testing of an engine

FUELS

Upon completion of this unit, the student will understand:

- Fuel pump testing procedures
  - Pressure tests
  - Capacity testing
  - Suction side testing
- The need for visual check of fuel lines, hoses, evaporative emissions systems
- Electric fuel pumps
  - Pusher type
  - Suction type
  - The use of resistor lines and oil pressure control switches for special by-pass circuits
- Fuel vapor lock
- Super-charger
  - Centrifugal type
  - Rootes type
- The theory of turbo chargers including related gate or diverter control valves
- Carburetors
  - Float
  - Idle
  - Low speed transfer
  - High speed
    - Main metering jets
    - Their identification and relationship to normal high speed
  - Power
    - Power valves
    - Metering rods
    - Power piston types
  - Accelerator
    - Cup type accelerator pump
    - Pump diaphragm type
  - Choke circuit
    - Bimetallic
    - Electric
    - Coolant types
- Where to find carburetor specification
- Setting float height and float drop adjustments
- Fuel idle mixture screws, limiter caps, and adjustments
  - External adjustments - primary
  - Secondary choke pull offs
  - Dechoke

Accelerator pump rods
Idle setting procedures and methods
Lean roll
Propane enrichment
Vacuum gauge adjustment
Fuel injection

ENGINES

Upon completion of this unit, the student will understand:

The need for proper cleaning and inspection of engine components
Hot tank
Steam
Ultrasonic
Proper procedure for removal of engine or engine and transmission assembly from a vehicle
Block inspection procedures
Determine defects
Extent of wear
Warpage
Internal and external cracks
Magnaflux
Sonoflux inspection
Stripped threads, etc.
Checking for excessive corrosion
Cylinder reconditioning procedures
Remove cylinder ridge
Reboring with boring bar
Honing with various stones to produce crosshatch pattern
Sleeving
Wet cylinder sleeves; its installation and sealing
Dry cylinder sleeves; its installation and sealing
How to measure piston clearances in the cylinder
How to measure cylinder bore, cylinder taper and cylinder out of round
Maximum taper and out-of-round limits
Piston sizing
Resizing-heat
Knurling
Inspection of crankshaft
Taper
Abnormal wear
Bends

Flat spots
Cracks
Reground crankshafts fitted with undersized fitted bearings
Typical bearing wear, patterns
Normal
Use of plastic gauge
Need for cleaning all oil passages - leak detection testing
Lift
Duration
The procedure for inspection and measuring of camshafts or dial indicating the necessity of special cambearing installation tools and precaution about proper bearing installation
The measurement of crankshaft end play - and connecting rod side clearance
Purpose and techniques for marking and keeping rods and caps together
How and why rods should be checked
Proper technique of fitting and installing bearing shell, sleeve-type bearings - "crush, spread"
Shells
Sleeve
Proper torquing and locking practices
Removing bearing shells and main seals
"Roll-out-pin"
"Chinese finger"
Replacement of freezeout plugs and oil gallery plugs
Various oil pumps and relief valves
Gear type
Rotor type
How to "prime" an oil pump and why this procedure is performed
Cylinder head reconditioning--general removal technique and precautions
Cast iron
Aluminum engines
Head assembly cleaning and inspecting
Checking for warpage
Cracks
Corrosion
Procedure for disassembly of heads (valves and springs in original position)
The cleaning, inspection, and grinding of valves
Inspection of valves for
Burns
Cracks
Warpage

Little or no margin
Worn or damaged stem
How to inspect valve guides
Various techniques for repair of valve guides
Use of reamer and oversized valves
Rebushing of guide
Knurling guides
The procedure for reconditioning valve seats
Determining valve seat concentricity
Various seat types
Induction hardened, inspect
How and when tyey are replaced
Narrowing and lapping
The various types of guide seals and their proper installation
Valve spring theory
Checking procedures squareness
Length
Compressing length
Positive rotation devices
Inspection of push rods, rockers, fulcrums and lock nuts, rocker arm assemblies
Proper valve adjustment procedures
Proper mechanical lifter adjustments: cold lash, hot lash, silent lash adjustment
Hydraulic lifter cleaning and checking, bleed down and time standards
Piston cleaning and inspection
Sizing rings for end gap and side clearance (mention use of spacers)
Piston resizing
Reheating
Knurling
Steel expander rings
Inspection techniques for timing belts, sprockets and chains, and gear assemblies

SUSPENSION

Upon completion of this unit, the student will understand:

- Suspension--refer to front and rear springs used to suspend a vehicle's frame, body, engine, and power train above the wheels.
  - "Sprung"
  - "Unsprung weight"
- The various types of springing devices
  - Leaf
  - Coil springs
  - Torsion bars
- The two types of front axle suspension generally used
  - Independent systems
  - Solid axle systems
- Independent suspension use of coil springs and torsion bars to include their mounting and non-interchangeability
- Shock mounting designs (including MacPherson strut)
- Ball joints--theory
  - Inspection and testing
  - Removal and installation procedures
- Upper and lower control arms, short-long arm design, stabilizer and and sway bars
- Stabilizer and sway bar purpose
- Solid axle systems
- King pin spindle designs
- Leaf spring construction and mounting
- Rear axle suspension combinations
  - Coil spring
    - Upper and lower control arms (strut rods)
    - Stabilizer bars
  - Leaf spring
- Shock absorbers
  - Double action
  - Air assisted shocks
- Why shocks are mounted on the bias
- The procedures for checking shocks
  - Bounce test
  - Leakage test
- Alternative suspension devices
  - MacPherson struts
  - Air suspension systems
  - Automatic leveling devices
- Steel wheel fabrication
  - Care
  - Service
  - Proper torquing procedures

STEERING

Upon completion of this unit, the student will understand:

- The two basic types of steering systems
  - Manual systems
    - Theory
    - Components of steering gear system
      - Steering wheel shaft (collapsible)
      - Gear box
      - Linkage
      - Knuckles
      - Wheel spindle assemblies
    - Types of manual steering gear
      - Worm and sector
      - Worm and recirculating ball
      - Rack and pinion systems
    - Sector shaft and worn gear adjustment
    - Flexible couplers
    - The theory of steering linkages and their inspection
      - Tierods
      - Drag links
      - Connector sleeves
      - Idler arms
    - Power steering systems
      - Integral type
      - Linkage - booster type power steering assemblies
      - The purpose and various types of common hydraulic pump
        - Vane
        - Slipper ring
      - Typical hydraulic control valve
      - Reading of a hydraulic schematic

ALIGNMENT

Upon completion of this unit, the student will understand:

- The changes in demands on steering components from early times-horse-drawn wagons to today's vehicles
- Front wheel angles
  - Caster
  - Camber
  - Toe-in
  - Steering axis inclination
  - Toe-out on turns
- Tools and equipment used to measure camber, caster, and toe-in
- The relationship of steering axis indication to
  - Toe-out on turns
  - Camber
  - Caster
- The importance of inspection of front-end components, suspension condition, and tire size
- The methods of adjusting the various angles
  - Shims
  - Eccentric adjustments
  - Bending techniques
- The effects of vehicle loading on
  - Tire wear
    - Normal war patterns
    - Wear "characteristics" which help in diagnosing alignment problems
- Alignment problems
  - Hunt
  - Pull
  - Wander

CHARGING SYSTEMS

Upon completion of this unit, the student will understand:

- Operation of charging system and voltage regulators
- The construction and basic operating theory of an alternator
- The similarities and differences between alternators and generators
- Physical components (fields, poles, permanent magnets, brushes) of alternators
- The differences in type of current produced (direct current v. alternating current)
- Converting AC to DC by use of rectifiers
- Why an alternator voltage regulator need not have a cut-out relay
- The use of transistors in voltage regulators
- All electrical testing must be done when a fully charged battery
- Basic technique used to check a charging system (voltmeter)
- The need to isolate individual component in order to properly diagnose charging system
- A voltage regulator isolation test
- An alternator output test and the factors effecting the results
- General alternator repairs
  - Replacing brushes
  - Bearing
  - Rectifier bridge or ring
- Diode testing procedures
- Rotor testing procedures
- The need to properly ground all electrical components
- Direct current generator devices, Types 1. 2. 3. Shunted
- "Polarizing" of generators
- Common generator repairs
  - Service lubrication
  - Replacing bearings
  - Brushes
  - Cleaning and cutting of commutator surface
- Inspection of generator components
  - Brushes
  - Brush holders and springs
  - Armature
  - Field coils
- The use of the "growler"
- The importance of proper voltage regulator setting to generator output and service
- Basic automotive electrical symbols and schematics
- "Circuits" and various electrical devices (control and protection)
- Use of volt, ohm and ammeter and their proper hook-up (parallel and series connections)

STARTING SYSTEMS

Upon completion of this unit, the student will understand:

- The components of starting system
  - Battery
  - Cables
  - Solenoids
  - Relay
  - Starter motor
  - Ring gear
  - Ignition switch
  - Neutral switches
- The purpose of the battery and its function in the starting system
- Starter cranking voltage test
- A high rate discharge test/starter current draw test
- Battery terminal cleaning techniques
- Neutral-safety switches/clutch neutral switches
  - Their function
  - Trouble shooting
- Starter relays and solenoids
  - Operation
  - Function
  - Trouble shooting
- Safety precaution to be remembered when removing or working on a starter in a vehicle (Disconnect battery from electrical system)
- Starter drive inspection and replacement
- Starter testing
  - Cranking voltage test
  - Cranking speed test
  - Starter draw test
- Basics of off-vehicle inspection (lock-up, bearings, and no-load test)
- Starter components and starter disassembly technique
- Starter motor reconditioning procedures
  - Inspecting armature
  - Replacing brushes
  - Solenoids
- Checking fields and internal connections and circuitry

DIFFERENTIALS

Upon completion of this unit, the student will understand:

The purpose of a differential assembly
The basic evolution of the differential
The identification of an uses of non-hunting, partial hunting and hunting gears
The power flow within a differential while driving straight ahead and while cornering
The basic operating components-construction and operation
The removable carrier and integral type assemblies
Pinion bearing adjustments depth and preload
Ring gear backlash adjustments-spanner and shim
How to read ring/pinion tooth contact patterns
How to inspect carrier components for wear and damage
How to determine correct carrier lubricant and proper filling procedures
How a "limited-slip" differential operates
How to replace a pinion seal
How to remove and service axle bearing and axle seals on flange and "C" clip type axle shafts
The difference in theory and service between regular, semi-floating and full-floating axle shafts
How to use a dial indicator to check carrier backlash and adjust axle lateral movement
The basic theory of a rear transaxle and its theory of operation
The basic construction of a front-drive transaxle and its theory of operation

AIR CONDITIONING

Upon completion of this unit, the student will understand:

The purpose and components of an automotive air conditioner - cool, clean and dry air
Basic "Physics" of states of matter
Solids, liquids and gases
Latent heat require or given off in change of state
The refrigerant R-12 and its physical properties and characteristics - safety precautions when working with Freon
The effects of pressurization on both vaporization and condensation of a liquid
The basic air conditioning components and each function
Compressor

Condenser
Reliever - Dehydrator
Expansion valve
Evaporator
Suction throttling valve
Sight glass

The need for evacuating the system before recharging

Servicing procedures including checking oil and recharging

SUGGESTED BIBLIOGRAPHY

EXPLORING ELECTRICITY/ELECTRONICS WITH THE ELECTRICAL TEAM, Phillip J. Rollain, Thomas E. Kraus. Delmar Publishers, Albany, NY, 1971

POWER TECHNOLOGY, George E. Stephenson, Delmar Publishing, Albany, New York, 1973

POWER MECHANICS OF ENERGY CONTROL, Ralph C. Bohn and Angus J. McDonald, McKnight & McKnight Publishing Co., Bloomington, Ill. 1970

SMALL GASOLINE ENGINES, Alfred C. Roth, Goodheart & Willcox Co., South Holland, Ill. 1975

GENERAL POWER MECHANICS, Crouse, Worthington, Margules, Anglin, McGraw-Hill Book Co., New York, N. Y., Second Edition, 1976

AUTOMOTIVE DIAGNOSIS AND TUNEUP, Johnson, McGraw-Hill Book Co., New York, N. Y., Second Edition, 1977

AUTOMOTIVE IGNITION SYSTEMS: DIAGNOSIS AND REPAIR, Derato, McGraw-Hill Book Co., New York, N. Y., 1981

AUTOMOTIVE TESTING AND DIAGNOSIS, Second Edition, SUN Electric Corp., Crystal Lake, Ill.

AUTO MECHANICS, Jay Webster, Glencoe Publishing Co., Encino, CA, 1980

ENGINE REPAIR: HEAD ASSEMBLY AND VALVE GEAR, Bob Barkhouse, Mc[illegible]night Publishing Co., Bloomington, Ill., 1975

FUNDAMENTALS OF SERVICE (FOS) COURSES, John Deere Distribution Service Center, Dept. 698, Moline, Ill., (Texts and slide sets)